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NATIONAL STEERING COMMITTEES FOR AERIAL APPLICATION OF PESTICIDES

REPORT NO. 1

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NATIONAL STEERING COMMITTEES FOR AERIAL APPLICATION OF PESTICIDES REPORT NO. 1

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PREFACE

In 1988, the Chief established national steering committees to be coordinated by Forest Pest Management Staff. The purpose of the committees is to focus expertise on the need for pilot tests for aerial application of pesticides and to develop an overall plan of action which could be executed by field units. Steering committees were identified to cover four subject matter areas: (1) defoliators of western conifers; (2) gypsy moth and other eastern forest defoliators; (3) insects of seed orchards; and (4) vegetation management.

The four reports contained herein represent findings and recommendations resulting from the first meeting of each committee. Appendices to the committee reports have been excluded. Also, included are the current drafts of guidelines for designing field experiments and pilot projects. The utility of this report includes: analysis of cost/benefit; documentation of pest management needs and accomplishments; background information for committee members, especially new members; and briefing and coordination document for cooperators.

The steering committees welcome comments and suggestions which can be forwarded to the Chief, Attn: Director Forest Pest Management, P.O. Box 96090, Washington, D.C. 20090-6090, (703) 453-9600.

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SECTION 1

A REPORT BY THE NATIONAL STEERING COMMITTEE FOR AERIAL APPLICATION OF PESTICIDES - GYPSY MOTH AND OTHER EASTERN DEFOLIATORS

November 14, 1988

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I. INTRODUCTION

A. Committee Members Attending

John Ghent, R-8/FPM (Asheville)
Felton Hastings, SE/FIDR
Win McLane, APHIS
Mike McManus, NE/FIDR
Dick Reardon, NA/FPM (AIPM)
Dan Twardus, NA/FPM
Jack Barry, WO/FPM (Davis), Chair
Max Ollieu, WO/FPM (attended but not a committee member)

B. Committee Objective

The meeting objective of the USDA Forest Service (FS), National Steering Committee for Aerial Application of Pesticides - Gypsy Moth and Eastern Defoliators (the committee), was to review the need for, and to recommend field experiment and pilot project testing of aerially applied pesticides for control of gypsy moth and other eastern defoliators.

C. Committee Procedures and Discussion

This is one of four national steering committees that will meet and report on needs and recommendations for field experiments and pilot project testing. The committee was established to focus expertise on the need for field testing of pesticides. Each committee will prepare and submit a report to the Chief. A consolidated summary report of the four committees also will be submitted to the Chief after the fourth national steering committee meeting in January 1989.

The initial meeting of the committee, as reported herein, was held at State College Inn, State College, PA, September 28-29, 1988. The next meeting of this committee has been scheduled tentatively for fall 1989 at State College, PA.

Prior to the meeting each member was requested to prepare a written report that reflected both technical and non-technical needs, and recommendations within the member's work area. Their reports are enclosed in Appendix B. The meeting began with each member presenting a narrative of the report, followed by a discussion. From these reports and discussions a series of recommendations, observations, and needs were formulated and presented for this report.

There was no attempt to suggest, except in a few cases, how management might address the recommendations, observations, and needs, nor who should perform the work. The committee proceeded on guidance that the FS will pursue a scientific and economically sound approach for evaluating aerially applied pesticides to control gypsy moth and other eastern defoliators.

Max Ollieu discussed national activities designed to improve the FS's posture in managing forest pests. These activities include the Forest Health Initiative, FIDR pesticide activity review, FPM pesticide use reviews, FPM reviews of MAG and Davis units, three regional pesticide technology need forums, and the four national steering committees for aerial application of pesticides. These activities and their resultant reports and action plans will provide information to a national committee with representatives from FIDR, FPM, TM, and TMR that will produce a charter and action plan for pesticide use management and coordination in the FS.

D. Definitions

These definitions were agreed to by the committee and do not necessarily conform to those stated in FSH 2109.11.

1. Cooperative Testing. Testing conducted jointly by FPM, FIDR, and other staff units. Tests may combine objectives of field experiments dnd pilot project tests.

2. Demonstration. A special project that demonstrates a technique or strategy in such a way as to gain acceptance and use.

3. Field Experiment. A research project that evaluates one or more treatment variables and controls under a variety of field conditions.

4. Pesticides. (1) Any substance or mixture of substances intended to prevent, destroy, repel, or mitigate any pest, or (2) any substance or mixture of substances intended for use as a plant regulator, defoliant, or desiccant.

5. Pilot Project. A special project that considers only a single treatment variable to determine the value of a new or improved material, technique, or strategy.

E. Pilot Project Discussion

The committee began its discussion developing a common ground definition of a pilot project. It was agreed that a pilot project is a scaled-up version of a field experiment. Viewpoints differed primarily on the size of pilot project blocks and the need to replicate treatments. Dan Twardus offered the following description (edited by Mike McManus) which the committee accepted in principle.

> A pilot project is a field demonstration of tested materials or methods proven to be field efficacious. The design of the pilot project test should reflect the varied conditions likely to be encountered in operational use.
>
> Size of the project should be adequate to demonstrate repeatability. One or more treatment blocks ranging in size from several hundred to 10,000 acres should be used. Pre-treatment

and post-treatment biological sampling should be conducted according to commonly accepted methods.

The objective of the project must be clearly stated in a project proposal. Each pilot project should be a demonstration of only one material or method. Results of a pilot project must be described in a report available for public review.

II. RECOMMENDATIONS

A. Cooperative Field Experiments and Pilot Project Tests

1. Conduct cooperative field experiments and pilot test of Gypchek against gypsy moth.

The standard application rate of Gypchek applied in two treatments is ready for pilot testing. There is need to field test a single application of a higher rate. This testing should be done cooperatively by FIDR and FPM.

2. Conduct cooperative field experiments and pilot tests of Foray, a Bacillus thuringiensis (B.t.) produced by Novo Biokontrol, Novo Laboratories, Inc. (Novo), against gypsy moth.

Foray is a new product that was tested in 1988 by Novo in Oregon against weatern spruce budworm, and in Virginia and New Jersey against the gypsy moth. It is an HD-1 strain formulated at 48 BIU per gallon and contains anti-evaporants. The level of testing for the 1989 field season is contingent upon review and recommendations of data by FIDR and FPM scientists.

3. Conduct cooperative field experiments of undiluted formulations of B.t. against gypsy moth.

To date the only undiluted B.t. tested in the east against gypsy moth has been an aqueous Dipel formulation. The committee places high priority on testing undiluted formulations that may be more efficacious and more economical to apply.

4. Conduct field experiments to study efficacy of registered tank mixes as a function of drop size, using rotary and conventional nozzles.

There is need to develop a data base for recommending drop size and type atomizer to control eastern defoliators. Cooperators are using a variety of equipment, results often are less than acceptable, and technically sound data are lacking to improve application.

B. Technical Recommendations

1. Establish a task group to develop recommendations for a study and a testing program to quantitatively account for aerially released pesticides.

The committee identified spray accountability as a high priority item. Generally we account for less than 30% of the spray released from aircraft. The amount is related to drop size, the larger the drops, the greater the accountability. The unaccountable 70% may be lost due to a combination of factors including evaporation, drop scavenging by foliage, deposition on the ground, and drift. Or the problem may be our inability to efficiently collect, sample, or assay the spray.

The FS should be in a position to account for sprays it releases in the atmosphere for environmental and economic reasons. The committee places high priority on this problem to obtain quantitative data on the fate of aerial sprays released in forests. Jack Barry volunteered to take the lead on organizing a task group. AIPM will be asked to fund the initial study phase of this proposed program.

2. Continue to enhance and evaluate FSCBG2 and AGDISP aerial spray models.

Aerial spray models are a powerful tool to study aerial application problems and to reduce dependence upon field testing. The committee places a high priority on transferring this technology to users, to enhancing the models, and to field evaluation of the models. It is recognized that the models are dependent upon accurate input data and emphasis should be placed upon obtaining data on droplet spectrum, evaporation rates for registered tank mixes, and canopy and leaf indices.

3. Determine effective and recommend standardized swath widths for spray aircraft and tank mixes used to control gypsy moth.

Applicators are using a wide range of swaths that compromises competitiveness and biological effectiveness. Data are needed to standardize effective swath widths for various aircraft and to develop contract specifications that produce efficacious results. The AGDISP spray model can be used to predict effective swaths and the results confirmed in the field as necessary.

4. Evaluate, test, and demonstrate methods to identify spray blocks, guide spray aircraft, and track spray aircraft in real time.

Existing technology such as Pathlink and global navigation systems are available to assist in guiding and monitoring spray aircraft. A system or systems need to be evaluated and adopted to FS needs, leading to specifications for aerial spray contracts. Such systems could reduce project costs and improve efficiency.

5. Need to develop spray deposit techniques for drop spread factor determinations that are not sensitive to moisture.

Spray deposit cards are the most practical means to assess drop size. For quantitative use of data from cards, a spread factor is needed to correct the stain size back to the drop size that produced it. Spread factors are determined in the laboratory with dry cards.

Often cards in the field are damp due to ground moisture and high relative humidity causing drops to spread beyond the level determined in the laboratory. When this occurs, results cannot be used to determine drop size and spray volume.

c. Administrative Recommendations

1. Develop protocol and guidelines for pilot project testing.

A protocol and guidelines are needed to assist coordination and peer review of pilot project proposals and plans. The committee is available to assist FPM and FIDR in developing protocol and guidelines. This is a national need for pilot testing.

2. Develop a 5-year B.t. program.

B.t. testing has been inefficient and piecemeal in both the East and West. An organized objective approach is needed to deal with the myriad of formulations, doses, rates, volume, adjuvants, dosages, drop size, effective drop density, viscosity, multiple application, and other factors in using B.t. to control gypsy moth. The committee recognizes that scarce resources must be used more efficiently and productively if we are to stay on top of the situation. Such a program should be cooperative between the East and West.

3. Establish guidelines for conducting a statistically sound field experiment.

Pesticide manufacturers and state cooperators have conducted field experiments which may not have been statistically based. Consequently the results are inconclusive or difficult to interpret. The committee believes the FS should encourage others to "share the burden" of field testing; however, test design should be comparable to that of FS field experiments. Mike McManus volunteered to take the lead on this recommendation and coordinate with FPM, FIDR, AIPM, and APHIS.

4. Establish coordinating procedures for field experiments and pilot project testing.

This steering committee could serve as a vehicle to coordinate field testing, and to establish procedures for identifying and recommending field experiments and pilot test. The multi-unit (FPM, FIDR, AIPM, and APHIS) membership of the committee provides an excellent forum to coordinate future testing, and to maximize available resources.

5. Monitor pest suppression to insure that standards are being met on federal cost-sharing programs.

The committee noted that quality of state cooperative programs varies widely and that the FS should exercise more control over cost-shared suppression projects. Monitoring would provide input for appropriate courses of action.

6. Establish a formal means to communicate with Canadian federal and provincial scientists on forest pest management.

The existing informal processes of interacting with our Canadian peers has not provided an adequate level of communications, resulting in lost opportunities. It is recommended that WO establish a technical exchange program.

III. OTHER OBSERVATIONS

1. Concern was expressed that on operational projects, number of acres treated is emphasized over quality of treatment.

2. Introduce a " Dan Twardus type" project monitoring and reporting procedures to the western regions.

3. Need to improve survey techniques for populations of gypsy moth.

4. Use of spray deposit technology too often ignored as a quality control measure.

5. Consider including spray pilots in FS and cooperator sponsored pesticide-use training.

6. Need to improve timing of larval treatment to maximize gypsy moth control.

7. Need to investigate gypsy moth clean-up strategies with pesticides such as pyrethroids.

8. Need to study non-target effects of B.t.

9. Need more research on gypsy moth pesticide dose-rate response.

10. Need to register insecticides before outbreaks begin.

IV. SUMMARY

The need to develop effective strategies and techniques to control gypsy moth was discussed in detail by the committee. The committee was provided considerable technical input by the Northeast Forest Aerial Application Technology Group, that had met prior to this committee meeting. With that input and that of the committee members, testing and other needs were identified and are presented in this report. The committee recognizes that the report calls attention to technical detail and some administrative needs. These details and needs are critical to conducting and improving the quality of field testing, pilot projects, and operational suppression programs. Each member expressed an appreciation for this steering committee and recommended it be maintained. Concern for prompt follow-up action by management and for the need to cooperate with all groups was continually echoed throughout the discussions.

SECTION 2

A REPORT BY THE NATIONAL STEERING COMMITTEE FOR AERIAL APPLICATION OF PESTICIDES - SEED AND CONE INSECTS

February 13, 1989

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B. Needs

IV. SUMMARY

APPENDIX (not included with DG message)

A. Meeting Agenda

B. Committee Members' Reports

I. INTRODUCTION

A. Committee Members

Larry Barber (absent)	R-8/FPM	(Asheville)
John Dale	R-5/FPM	(San Francisco)
Gary DeBarr	SE/FIDR	(Athens)
Jed Dewey	R-1/FPM	(Missoula)
Mike Haverty	PSW/FIDR	(Berkeley)
Chris Niwa	PNW/FIDR	(Corvallis)
Pete Rush	NA/FPM	(St. Paul)
Roger Sandquist	R-6/FPM	(Portland)
John Taylor	R-8/FPM	(Atlanta)
Jack Barry	WO/FPM	(Davis) Chair

B. Committee Objective

The meeting objective of the USDA Forest Service (FS), National Steering Committee for Aerial Application of Pesticides - Seed and Cone Insects (the Committee), was to review the need for, and to recommend field experiments and pilot project testing of aerially applied insecticides for control of seed and cone insects. This objective was expanded by the Committee to include ground application and to include seed and cone producing areas other than seed orchards.

C. Committee Procedures and Background

This is one of four national steering committees that is meeting in 1988-89 to report on needs and recommendations for field experiments and pilot project testing. The Committee was established to focus expertise on the need for field evaluation of pesticides, equipment and strategies. Each committee is preparing and submitting a report to the Chief. A consolidated summary report of the four Committees also will be submitted to the Chief after the fourth national steering committee meeting in January 1989. The initial meeting of the Committee, as reported herein, was held at Harbor Inn, Sacramento, CA, November 16-17, 1988.

Prior to the meeting each member was requested to prepare a written report that reflected both technical and non-technical needs, and recommendations within the member's work area. Their reports are enclosed in Appendix B. The meeting began with each member presenting a narrative of the report, followed by a discussion. From these reports and discussions a

series of recommendations, observations, and needs were formulated and presented for this report.

There was no attempt to suggest, except in a few cases, how management might address the recommendations, observations, and needs, nor who should perform the work. The Committee proceeded on guidance that the FS will pursue a scientifically and economically-sound approach for evaluating aerially applied insecticides to control seed and cone insects.

The meeting is one of several to improve the FS's posture in managing forest pests. Other activities include the Forest Health Initiative, FIDR pesticide activity review, FPM pesticide use reviews, FPM reviews of MAG and Davis units, three regional pesticide technology needs forums, and the four national steering committees for aerial application of pesticides. These activities, and their resultant reports and action plans, will provide information to a national committee with representatives from FIDR, FPM, TM, and TMR that will produce a charter and action plan for pesticide use management and coordination in the FS.

D. Definitions

These definitions are for reference and do not necessarily conform to those stated FSH 2109.11.

1. Cooperative Testing. Testing conducted jointly by FPM, FIDR, and other staff units. Tests may combine objectives of field experiments and pilot project tests.

2. Demonstration. A special project that demonstrates a technique or strategy in such a way as to gain acceptance and use, usually without replication.

3. Field Experiment or Test. A replicated research project that evaluates one or more treatment variables and a control.

4. Pesticide. (1) Any substance or mixture of substances intended to prevent, destroy, repel, or mitigate any pest, or (2) any substance or mixture of substances intended for use as a plant regulator, defoliant, or desiccant. An insecticide is a pesticide used to control insects.

5. Pilot Project or Test. A special project that considers only a single treatment variable to determine the value of a new or improved pesticide, technique, or strategy.

The term insecticide is used in lieu of pesticide as the report focuses on control of seed and cone insects.

E. General Discussions

Committee representation was provided by PNW, PSW, and SE stations; and by FPM (R-1, R-5, R-6, R-8, and NA).

Aerial application is the primary means of delivering insecticides to seed orchards in the South and Southeast. Since 1980 aerial application has become accepted as a safe and economical method of applying insecticides to control seed and cone insects in both federal, state and private seed orchards. For a variety of reasons use of aerial application is an exception in federal orchards in other geographic areas of the U.S. Reasons suggested by the Committee included: proximity of seed orchards to residential areas; perception that aerial application results in more drift than ground application; and low awareness level of the utility of aerial application.

The Committee recognizes the relative advanced state-of-the-art used to manage seed and cone insects in the South and Southeast. This suggests that other federal, state, and private forestry entities in other geographical areas of the U.S. might benefit from increased coordination and technology transfer. The Committee further recognizes that the need for protection of seed crops from insects will continue until advances such as tissue culture replaces the need for cultivated seed. This obviously is in the distant future.

The Committee elected to include ground application within the scope of the discussions, recommendations, and needs because such a large portion of the seed orchards are treated by ground application of pesticides. In addition to seed orchards, discussions also included control of seed and cone insects in seed production areas, wild stands, and seed-tree harvest sites.

Potential use of pheromones for monitoring and controlling insects was discussed enthusiastically, concurrent with the need to broaden methods and tools, and to add narrow spectrum insecticides to the inventory of seed and cone insect management tools.

FIDR nationally has identified seed and cone protection as one of the highest priority areas needing research as discussed in the FIDR 10-year plan.

Orchards in the Northwest and California tend to be small (<20A) and future orchards in the northwest will probably be small with emphasis on efficiency and productivity. These orchards will require more intense pest management. Size influences the selection of an insecticide application method. Small widely scattered areas may or may not be economical to treat aerially. Remote sites may be too distant from commercial aerial applicators or too small an acreage to be of interest. On the other hand, aerial application may be the only practical option. This argues for the need to evaluate non-aerial or a combination of insecticide application methods.

There appears to be a general perception that aerial application causes more drift and, therefore can be an environmental threat. It is not generally known that insecticide applied by ground usually requires higher amounts of active ingredient compared to aerial application. Ground application also may exceed 300 gallons per acre compared to 5 gallons per acre for aerial application.

The subject of test replication and test controls was discussed by the Committee. It was agreed that replication and controls also are needed for pilot projects; however practical limitations associated with testing in producing orchards often preclude traditional test design.

II. RECOMMENDATIONS

Recommendations are not presented in order of priority.

A. Field Experiments and Related Studies

1. Conduct field experiments to study the impact and economic thresholds associated with different densities of insect pests and seed crops.

There is an important need to know when control is necessary and what the consequences will be for not treating pests when their population have reached a given level of infestation. Development of a pheromone driven monitoring system should be an integral part of this research. Currently in western U.S. and Canada a monitoring system exists for only one seed and cone insect. Some orchards are treated 5 times a year with broad spectrum insecticides as orchard managers often are not willing to risk significant losses. Treatment prescriptions could be provided if the impact of infestation levels were known. More efficient and less use of insecticides would be the end result of this research. Related to these impact studies and to the

optimum timing study discussed below, is the need to thoroughly understand the life cycles and habits of seed and cone insects.

2. Conduct field experiments to determine optimum timing of control activities.

The rationale for this recommendation is founded, in part, on the above discussion. Optimum timing of insecticide application can reduce the number of treatments. The "spray window" for some insects can be only days. Therefore, development of methods to monitor presence of pests without extensive sampling of the cone crop and population levels are potentially promising and critically needed. These studies should explore the utility of pheromones for timing of insecticide applications and provide data on insect activity cycles and patterns, and to estimates of population levels.

3. Conduct laboratory and field experiments of promising insecticides, including pheromones, for control of seed and cone insects.

The number of effective insecticides for control of seed and cone insects is limited. The private sector is not pursuing registration of insecticides for seed and cone insects, and the possibility exists that some insecticides with current labels may lose registration. There is an urgent need to increase the inventory of insecticides including Bacillus thuringiensis (B.t.), pheromones and other narrow-spectrum insecticides.

4. Conduct field tests to establish the scientific soundness of using Cygon 2E, Dimethoate, Pydrin and/or Permethrin to control seed and cone insects in Douglas-fir seed orchards.

Current practices involve applying systemic Cygon early in cone development for control of Douglas-fir cone gall midge and cone moth, followed by one or more applications of other insecticides for control of Douglas-fir seed chalcid and fir coneworm. These effective, but broad spectrum insecticides, may be effective at lower dosages and at a reduced number of treatments.

5. Initiate laboratory and field testing of B.t. for control of seed and cone insects.

There is need to test existing and new strains of B.t. against some seed and cone insects in the East and West. Materials should be screened in laboratory and

promising materials field tested by ground and aerial methods.

6. Conduct field experiments in the West to evaluate the feasibility and economics of aerial methods to protect trees in wild stands.

Seed crops on superior trees in seed production areas, and seed trees left in seed tree cut require protection. Location and tree height often preclude ground treatment. This experiment would involve a helicopter equipped with a special spray system adapted or designed for single tree treatment. The Committee suggests that MTDC and PSW cooperate on this experiment.

7. Conduct sub-studies in conjunction with field experiments and pilot projects to develop and evaluate spray deposition sampling methods.

Existing methods of spray deposit sampling do not provide consistent and reliable data. Practical field methods are needed that provide quantitative data on the amount of tank mix and active ingredient that deposit on the foliage and on the ground. Deposit data are needed to correlate with levels of biological control when evaluating lower rates of existing insecticides and when testing new insecticides.

B. Demonstrations and Pilot Projects

1. Conduct demonstration projects to evaluate efficacy and drift of air blast ground sprays compared to aerial application.

Aerial application has been demonstrated to be more efficacious in controlling seed and cone insects in the South when compared to ground application methods. Tests have not been conducted to determine whether this is equally true in the West. Quantitative data on drift associated with ground vs aerial treatments in seed orchards are needed throughout the U.S. Concurrent with these comparative evaluations is the need to evaluate methods to reduce spray drift from ground sprayers.

2. Conduct ULV field projects to evaluate Malathion, Guthion WP, Guthion EC, Guthion 3F, Asana, and *B.t.* for efficacy and to gather environmental fate data.

ULV has a high potential for reducing the amount of insecticide required to achieve efficacy. Reducing the amount of insecticide would provide a corresponding reduction in environmental contamination and cost.

3. Monitor the movement and fate of insecticides applied to seed orchards.

Quantitative data are needed on the movement and fate of insecticides in the air, in soil, in ground water, on foliage; and the adverse effects on acquatic insects and other non-organisms for each insecticide and application method.

4. Evaluate and demonstrate the utility of the Agricultural Dispersal (AGDISP) and Forest Service Cramer-Barry-Grim (FSCBG) aerial spray models for planning, conducting, and evaluating aerial and ground application of insecticides.

An earlier version of FSCBG was used to plan a successful aerial application test conducted at the Withlacoochee, State of Florida, seed orchard in 1980. Both models need to be evaluated for their utility in planning, conducting, and evaluating insecticide application in seed orchards. This can be done concurrently with or as an integral part of other seed orchard tests.

C. Administrative

1. WO/FPM explore opportunities with EPA to exempt or reduce seed and cone insect pheromones from registration and/or develop a FS policy on development of seed and cone insect pheromones.

This recommendation pertains to FIFRA requirement to register all materials used to control insects. The Committee expressed concern that EPA registration requirements for pheromones as they currently exist may deter the private sector from development, testing, and marketing micro-use seed and cone insect pheromones. If registration requirements of micro-use pheromones are not modified by EPA, FS should develop a policy on whether to proceed or how to proceed in development, testing, registration, and production of seed and cone insect pheromones. The Committee feels that this is an important issue needing renewed coordination between FPM and FIDR.

2. WO/FPM review R-8's 5-year seed and cone insect plan and take action.

This Committee is available to assist WO in evaluating alternative courses of action discussed in the 5-year plan. Addressed in the plan are proposals that may lead to safer, and more effective and economical use of pesticides.

3. WO/FPM and FIDR explore ways to enhance coordination of seed and cone insect research and development nationally.

Options should be explored to increase coordination and flow of technology east and west, and with our Canadian and Mexican partners. This may take the form of multi-regional IPM/seed and cone specialist positions shared by FPM and FIDR.

4. Explore ways to obtain project funding during the first quarter of the fiscal year of the project.

Funding commitments on a project by project basis should be finalized no later than the first quarter of the fiscal year of the project. Insecticide-use projects require early commitments to secure contracts and resources.

5. Continue the Committee and expand its role as a coordination network for working groups, ad hoc committees, information exchange, and consultations.

The Committee identified a need for increased communication and technical exchange among seed and cone insect pest managers. The Committee can serve as a catalyst.

III. OTHER OBSERVATIONS AND NEEDS

A. Observations

1. SE Station does not have resources to conduct adequate aerial spray tests in seed orchards.

2. PSW Station is not geographically located to conveniently conduct studies of seed and cone impact and biology.

3. There are opportunities for more interaction between FPM and FIDR field units. Barriers are mostly administrative and geographical.

4. There are opportunities to increase cooperative projects between NC Station and NA/FPM (St. Paul).

B. Needs

1. Need to pursue more creative ways to supplement an aging scientific work force, assuming continued downward pressure on hiring, and to develop a personnel resource plan. Ways suggested include FPM/FIDR dual responsibility positions, post-doctoral and graduate

student arrangements, university cooperative personnel resource, continuity through permanent full-time technicians, and FPM/FIDR seed and cone multi-regional projects similar to the W-110 project for bark beetles and root disease.

2. Need sites with adequate seed orchards to conduct replicated tests. Most orchards are producing seed and managers cannot afford to provide areas for testings. This limits testing opportunities. With limited travel funds and personnel it is difficult to conduct tests even at "moth balled" orchards. Nevertheless "moth balled" orchards should be identified and pursued for possible testing sites. As the South moves into F-2 orchards, many F-1's are becoming available. This may also be a possibility in the Northwest.

3. Need to evaluate methods to prevent and control secondary pest outbreaks, especially those caused by other pest management activities.

4. Need to proceed in developing a list of recommended protective clothing and equipment for seed orchard personnel who handle restricted-use insecticides.

5. Need to evaluate existing or to develop new hardware for applying aerial sprays to single or clustered trees. Seed collection trees in wild stands seldom can be treated effectively from the ground. Aerial application currently is the only practical method of treatment. A helicopter spray system is needed. This may simply involve testing or modifying an existing system. It is suggested that WO/Engineering be requested to evaluate an aerial spray system.

6. Need a tree injection or infusion method that is safe, economical, and minimizes tree damage. High resin levels in pines present a tough problem. WO/Engineering should be requested to pursue this problem.

7. Need an engineering study to evaluate both ground and aerial equipment for dispersal of pheromones in tubes, capsules, flakes, pellets, and granules. The study to be conducted in close coordination with FIDR should evaluate existing hardware and identify need for hardware development. The Committee suggests that WO/Engineering be requested to pursue this study.

8. Need permanent full-time technicians assigned to seed and cone insect scientists. Technicians provide for more efficient and cost effective use of professional's time. Additionally the nature of seed

and cone studies often are multi-year, and there is need for continuity that technicians can provide to staffs and projects.

9. Need field methods to detect and assess ultra low volume (ULV) sprays. Physical, chemical, and biological methods are needed to assess aerial sprays; and to provide data on coverage, drop size, volume, and air concentration. ULV spraying provides an opportunity to reduce application rates and volumes, thus leading to safer and more economical use of insecticides.

10. Need to consolidate the Southeast's pheromone data-base. Currently it is spread over 3 computers. This could be done by identifying a focal point and putting data into a single data-base program.

IV. SUMMARY

The National Steering Committee for Aerial Application of Pesticides - Seed and Cone Insects reviewed the need for field experiments and pilot testing to support management of seed and cone insects. Other needs consistent with improving management of seed and cone insects were reviewed and are presented in this report. The Committee identified seven needed work areas as follows: alternatives to chemical insecticide; monitoring seed and cone insects; pheromones; assessing impact of seed and cone insects; studies of insect biology and application timing; ultra low volume application; and environmental monitoring and impact. The Committee recommends its continuance as a coordinating body.

SECTION 3

A REPORT BY THE NATIONAL STEERING COMMITTEE FOR AERIAL APPLICATION OF PESTICIDES - WESTERN DEFOLIATORS

November 9, 1988

I. INTRODUCTION

A. Committee Members

Gary Daterman, FIDR/PNW
Dennis Hamel, WO/FPM
Jim Linnane, R-3(RO)/FPM
John Neisess, R-5(RO)/FPM
Iral Ragenovich, R-6(RO)/FPM
Pat Shea, FIDR/PSW
Larry Stipe, R-1(RO)/FPM
Julie Weatherby, R-4 (Boise Field Office)/FPM
Jack Barry, WO/FPM (Davis), Committee Chair

B. Committee Objective

The meeting objective of the National Steering Committee for Aerial Application of Pesticides - Western Defoliators (the committee) was to review the need for, and to recommend field experiment and pilot project testing of aerially applied pesticides for control of western defoliators. The committee also took the opportunity to recommend administrative, procedural, and testing needs.

C. Committee Procedures

The initial meeting of the committee, as reported herein, was held at the Harbor Inn, West Sacramento, CA, October 4-5, 1988. This is one of four national steering committees that will meet and report on needs and recommendations for field experiments and pilot projects involving the aerial application of pesticides. Each committee will prepare and submit a report to the Chief. A consolidated summary report of the four committees also will be prepared after the fourth committee meeting in January, 1989.

The committee activities is one of several FPM and FIDR national activities. These include the Forest Health Initiative, FIDR activity review, FPM pesticide-use reviews, FPM reviews of MAG and Davis units, and three regional pesticide technology need forums. These activities and their resultant reports and action plans will provide information to a national committee with representatives from FIDR, FPM, TM, and TMR that will produce a charter and action plan for pesticide use management and coordination in the USDA Forest Service (FS).

Prior to the meeting each member was requested to prepare a written report that reflected both technical and non-technical needs within the member's work area. These reports, as submitted, are enclosed (Appendix B). The meeting began with each member presenting a narrative of the report, followed by a discussion. From these reports and discussions a series of recommendations, observations, and needs were formulated. They are presented in this report.

There was little attempt to suggest, except in a few cases, how management might address the recommendations, observations, and needs nor who should perform the work. The committee proceeded on guidance that the FS will pursue a scientific and economically sound approach for evaluating aerially applied pesticides to control western defoliators.

D. Definitions

These definitions were agreed to by the committee and do not necessarily conform to those stated in FSH 2109.11.

1. Cooperative Testing. Testing conducted jointly by FPM, FIDR and/or other staff units. Tests may combine objectives of field experiments and pilot tests.

2. Demonstration. A special project that demonstrates a technique or strategy in such a way as to gain acceptance and use.

3. Field Experiment. A research project considering several treatment variables.

4. Pesticides. (1) Any substance or mixture of substances intended to prevent, destroy, repel, or mitigate any pest, or (2) any substance or mixture of substances intended for use as a plant regulator, defoliant, or desiccant.

5. Pilot Project. A special project that usually considers only a single treatment, identified from field experiments, to determine the value of a new or improved material, technique, or strategy when used under operational conditions.

II. RECOMMENDATIONS[1].

A. Field Experiment Testing

1. Conduct field experiments of new strains of Bacillus thuringiensis (B.t.) against western spruce budworm as recommended by PNW (Project 4502).[2].

One and possibly other new "strains" of B.t. will be ready for field testing during the spring of 1989. These are not genetically engineered (DNA manipulated) strains, but rather bred strains referred to as transconjugal crosses. A strain, identified as Condor-OF (HD-269) and produced by Ecogen, has been evaluated in the laboratory by PNW, has an experimental use permit, and is ready for field testing. The committee places a high priority on field testing microbials that have demonstrated significantly improved efficacy in the laboratory.

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[1]. Recommendations are listed by priority in descending order with number 1 being first priority for field experiment (II.A.) and pilot project testing (II.B.). Priorities were not assigned for Other Recommendations (II.C.).

[2]. A list of B.t. products is provided in Appendix C for reference and clarification.

2. Conduct a cooperative field and pilot test of the Novo BioKontrol, Novo Laboratories, Inc. (Novo) product Foray 48B against western spruce budworm.

Novo privately field tested Foray in Oregon during the spring of 1988. The committee feels that the data from this test is not adequate to support operational use; therefore, a combined cooperative (FPM and FIDR) field and pilot test should be conducted during the spring of 1989 testing application volume. The Foray test would test more than one variable.

3. Conduct mini-pilot tests (blocks 50 to 500 acres) of lower B.t. volumes (less than 43 oz/ac.) of established B.t. products.

Data from Maine and Canada suggest that volumes as low as 24 ounces per acre may be effective depending upon control objectives. Success during 1988 in Oregon with 42.7 ounces per acre further supports testing lower volumes. The B.t. manufacturers have been urging the FS to consider lower volumes citing successes against spruce budworm and improved formulations. Dipel 8L applied at 32 ounces per acre would be a likely candidate.

4. Conduct a pilot test to obtain registration data for one or more pesticides to control pandora moth in R-6.

Current pandora moth infestations in Oregon have potential for expanding and requiring control. There are no registered pesticides to control pandora moth. Orthene was demonstrated to be efficacious in Arizona, however, it is not registered.

C. Other Recommendations

1. Conduct a field project to demonstrate aerial mating disruption with pheromone to suppress western pine shoot borer damage in ponderosa pine plantation.

Research data supports demonstrating this suppression strategy in ponderosa pine.

2. Develop a method to identify key personnel for assignment to the Incident Command (IC) System, and include and train FPM personnel in IC System.

This topic has been discussed since 1976 and the committee recommends that an identification method be developed with no further delay. The committee understands that a system is being developed by WO.

3. Assign on pilot projects IC team an FPM person as incident commander or deputy incident commander, and designate project entomologist to report directly to incident commander.

The committee expresses its concerns that the IC System does not provide a safeguard for the scientific integrity of a project and recommends that a scientist be assigned in the upper command structure. Further the project entomologist should report directly to the upper command and not be subordinated to an operational section in the organization. This should be included in FSH 2109.11.

4. Establish a western center for pesticide application technology.

The FS should establish a western center for pesticide research and application technology. There is need to provide state-of-the-art technology to pesticide users to include evaluating application systems, obtaining input to models, and evaluating monitoring and sampling methods. It should be a FS managed center as experience has shown that FS needs would be dominated by non-forestry interests if other agencies were included as partners. The committee is available for consultation on this matter.

5. Pursue registration and experimental use permits (EUP) for pheromones and viruses.

The committee suggests that WO/FPM identify a specific contact to coordinate the pursuit of pesticide registration and EUP.

6. Involve FIDR scientists in initial planning of pilot tests.

FIDR scientist(s) should be involved early-on in planning pilot tests and when appropriate should be part of the pilot project team. This will provide critical FIDR input, support team play, and enhance communications.

7. Conduct field experiments and pilot projects jointly and cooperatively between FIDR and FPM and other staff units as appropriate.

There are several examples of FIDR and FPM cooperation. There are opportunities to pursue this more aggressively especially in the area of cooperative field experiments and pilot projects.

8. Maintain the traditional approach to field and pilot testing.

The committee supports the traditional approach to field and pilot testing pesticides, techniques, and strategies is sound and should be continued. A pilot test can be described as a scaled-up field experiment that tests the resilience of procedures developed during field tests. Emphasis in the future should be on tests that are well designed, economical, and cooperative.

9. Maintain this committee as an advisory panel, as a forum for communications, and as a source for input and review as appropriate to field projects.

The committee strongly supports the continuation of this committee as a means to promote communications, cooperation, and coordination.

10. Request WO/Engineering to provide technical assistance to evaluate, in conjunction with pilot tests, aircraft guidance and spray monitoring systems.

Technological advances in recent years make it possible to track and monitor spray aircraft in real time, to guide aircraft to spray blocks, to assist pilots in maintaining swaths, and to monitor and regulate flowrates. These systems have the potential of reducing aerial observation aircraft and otherwise increasing the efficiency of aerial application. Systems are available; however, they need to be

evaluated and engineering specifications developed, tailored to FS needs. MTDC has an on-going related project and they previously have assisted FPM on aircraft guidance. Engineering expertise is needed to preclude a costly hit and miss approach in packaging a system tailored to FS needs using existing technology.

11. Establish documented guidelines for conducting a statistically sound field experiment.

Pesticide manufacturers and state cooperators have conducted field experiments which may have not been statistically sound. The committee believes the FS should encourage others to "carry the burden" of field testing; however, test design should be comparable to that of FS field experiments. Pat Shea volunteered to develop guidelines, based upon a previously published paper, and do this in coordination with Gary Daterman and Mike McManus.

12. Publish results of the 1988 Meacham R-6 pilot project in an appropriate scientific journal.

The FS should provide incentives to encourage all FS scientists to publish in refereed journals. Important data generated by FPM such as the Meacham data should be shared with the scientific community. Working more closely with Research scientists in the future, sharing authorships, and rewarding FPM scientists for publishing might be considered by management.

13. Establish a consistent approach for the use of suppression techniques in western spruce budworm management in the western Regions. Specific issues are effectiveness of suppression programs and economic analysis procedures to determine the need for, and the benefits from such programs. An underlying issue is pesticide use in forest environments.

The FS needs a Service-wide western spruce budworm strategy that is consistent and defensible. The committee recognizes that due to geographic and economic reasons, western spruce budworm management differs from region to region; however, there should be a clear strategy bound by a common rationale. The public is entitled to know FS policy and strategy in managing western spruce budworm, and the policy should be clearly stated and consistently administered.

14. Evaluate current and potential aerial application strategies for management of western spruce budworm populations in high value areas (i.e. seed collection sites, plantations, recreation/scenic areas, and other high value timber stands). There is a need to examine old ways and to seek new approaches.

Long standing issues surrounding budworm management have been the longevity of pesticide treatments, particularly B.t. These are: (1) the entomological unit philosophy requiring the treatment of entire entomological units (specific topographic or political boundaries associated with an infestation) versus a targeted spraying strategy of treating only areas or stands where resource objectives are eminently and severely threatened by the pest (reinvasion, resurgence, and multi-treatment issues); and (2) do suppression programs contribute to meeting long-term and short-term resource

objectives (monitoring issues). Clear answers to these questions are seldom agreed upon by various parties in FPM, research, and interested publics.

15. Prepare a review publication of past field tests, pilot tests, and operational projects of pesticides that are currently available or may be available against western defoliators and update annually.

Such a reference would be helpful in the field project planning process and perhaps reduce duplication. Julie Weatherby agreed to develop an outline for this publication.

16. Accelerate training, use, and enhancement of computer based aerial spray models (FSCBG2 and AGDISP) in planning, conducting, and evaluating aerial spray projects.

Models provide a powerful tool to simulate field application. Model application with accurate input parameters can reduce the scope of costly field projects. They can be used more vigorously in developing aerial contract specifications and treatment strategies. Additionally they can be used during the field conduct to provide advice to the project leaders and during post-spray operations for project critiques. Personnel need to be trained on the models and the models need to be evaluated and enhanced as needed.

17. Establish source or sources for data on droplet evaporation and droplet atomization of tank mixes.

Data on droplet evaporation and atomization are critical inputs to the aerial spray models. The FS has no facility to obtain these data. A source needs to be identified and a protocol established to provide these data.

18. Fund pilot projects adequately and do not subordinate under operational projects.

Funds provided by WO for suppression and control projects should have side-boards to insure the funds are used for the intended, agreed-to purpose.

III. OBSERVATIONS

A. Administrative

1. Concern that forest supervisors do not follow FPM recommendations even though they are both scientifically and economically sound. It is recognized that the Forest Health Initiative may bring focus on the resolve of this problem.

2. Need for more thorough documentation of all field projects.

3. Need to insure availability of several pesticides for each major western defoliator for both biological and economic reasons.

4. Need a reference publication on spray equipment to supplement the Program WIND publication titled "Aerial Application Equipment."

5. Need to update FS Handbook 2109.11 as it relates to pilot testing and the IC system. Confusion exists on this subject. The handbook should include standards and guidelines for pilot projects. Dennis Hamel has begun this update.

6. Need a procedure to maintain communications with pesticide manufacturers to insure that managers have correct information and that scientists have updated data. Dennis Hamel will discuss this with Max Ollieu and Jim Space.

7. Need to maintain a vigilance against the treadmill of field testing every formulation variant of B.t. This is a resource drain and we need to look for low-cost and technically sound ways to obtain information and field data.

B. Technical

1. Need to look ahead to use of expert system technology for pest management including aerial application technology.

2. Need a source or sources to obtain spray technology data and information on items such as spray deposition, atomization, droplet spectra, spread factors, pesticide chemistry and physical properties, evaporation, etc. on an on-going basis. The committee recognizes that this need is being addressed, in part, by work units and the national pesticide application specialist at Davis but these current FS resources are inadequate both in staffing and funding. This technical observation relates in part to recommendation II.C.3.

3. Need to include spray deposit and/or other methods of sampling on all spray projects to quantitatively monitor quality of application.

4. Need to accelerate the technology transfer and use of pheromones as the FS may be losing benefits of an effective tool.

IV. SUMMARY

The National Steering Committee for Aerial Application of Pesticides - Western Defoliators reviewed the need and made recommendations for field experiments and pilot testing of pesticides. The scope of the committee naturally evolved to identifying other related recommendations and needs. The committee sees a need to maintain the committee as a forum for communications and consultation.

APPENDIX C

List of B.t. Products[1/]

Manufacturer	Formulation	Strain	Pests	Rate/Volume	Status
Novo	Foray 48 BIU/Gal	HD-1	GM SBW	1 1/3 - 3 1/3 pt/A	Field/Pilot test
Ecogen	Condor OF 64 BIU/Gal	HD-269 Trans-conjugal cross	SBW GM	1 qt/A	Field test
Abbott	Dipel 6L 48 BIU/Gal	HD-1	SBW	43 oz/A	Operational
Abbott	Dipel 6AF 48 BIU/Gal	HD-1	SBW GM DFTM	43 oz/A 1 1/3 - 3 1/3 pt/A 1 1/3 pt/A	Operational
Sandoz	Thuricide 32LV 32 BIU/Gal	HD-1	SBW GM DFTM	24-80 (eg. 64) oz/A 32-80 oz/A 16-32 oz/A	Operational
Sandoz	Thuricide 48LV 48 BIU/Gal	HD-1	SBW GM DFTM	16-53 (eg 43) oz/A 22-53 oz/A 11-22 oz/A	Operational
Sandoz	SAN 415 SC 32LV w/anti-evap 32 BIU/Gal	NRD-12	SBW GM	24-48 oz/A	Field/12 BIU Pilot/16 BIU

1/ Information compiled by Dennis Hamel - October, 1988.

SECTION 4

A REPORT BY THE NATIONAL STEERING COMMITTEE FOR AERIAL APPLICATION OF PESTICIDES - VEGETATION MANAGEMENT

April 6, 1989

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I. INTRODUCTION

A. Committee Members

B. Committee Objective

C. Committee Procedures and Background

II. NEEDS AND ISSUES

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IV. SUMMARY

I. INTRODUCTION

A. Committee members

Phil Aune	PSW/TMR	(Redding)
Dave Caraher*	R-6/RO	(Portland)
M.Boyd Edwards*	SE/TMR	(Dry Branch)
Dave Evans	Modoc NF	(Alturas)
Larry Gross	WO/FPM	(Washington)
Charles McMahon	SO/TMR	(Auburn)
Paul Mistretta*	R-8/RO	(Atlanta)
Ed Monnig	R-1/FPM	(Missoula)
Donald Perala	NC/TMR	(Grand Rapids)
William Stein	PNW/TMR	(Corvallis)
Bob Taylor	R-8/NF's-MS	(Jackson)
Larry Yarger	NA/FPM	(Milwaukee)
Jack Barry, Chair	WO/FPM	(Davis)

B. Committee Objective

The objective of the USDA Forest Service (FS) National Steering Committee for Aerial Application of Pesticides - Vegetation Management was to review the needs and recommend pilot project and field testing of aerially applied herbicides. The discussion was expanded by the Committee to include ground applications.

C. Committee Procedures and Background

This is one of four national steering committees appointed by the Chief to report on needs and recommendations for pilot project and field testing. Reports of the other three committees have been submitted previously to the Chief. The committees were established to focus expertise on the need for field evaluation of pesticides, equipment, and strategies. A consolidated summary report of the four committees will be prepared and submitted to the Chief in 1989. The initial meeting of this committee, as reported herein, was held at the Harbor Inn, Sacramento, CA, January 11-12, 1989.

Prior to the meeting, each member was requested to prepare a written report that reflected both technical and non-technical needs and recommendations from the member's work area. In addition to the reports serving as discussion documents at the meeting, they will be included as an appendix to the consolidated summary report. The meeting began with each member presenting a narrative account, followed by a discussion. From these reports and discussions, herbicide application needs and issues were identified. There was no attempt to suggest, except in a few cases, how management might address the needs and issues.

*These persons were unable to attend meeting.

This meeting is one of several initiatives that focus on reducing losses from forest pests. Other activities include the Forest Health Initiative, Forest Insect and Disease Research (FIDR) pesticide activity review, Forest Pest Management (FPM) regional pesticide use reviews, FPM reviews of Methods Application Group (MAG) and Davis units, three regional pesticide technology needs forums, and the three other national steering committees for aerial application of pesticides. These activities, and their resultant reports and action plans, will provide information to a national planning committee composed of representatives from FIDR, FPM, Timber Management (TM), and Timber Management Research (TMR) that will produce a charter and action plan for pesticide use management and coordination in the FS.

II. NEEDS AND ISSUES

A. General

Seven categories of needs and issues were developed by the Committee after the members presentations and discussions. There was some discussion on priorities; however the Committee choose to defer assigning priorities to the next Committee meeting.

B. Needs and Issues

1. Administrative

a. Coordination

Improved coordination and direction are needed nationally within the FS on herbicide research. The Committee could not clearly identify organizational responsibility and direction of herbicide research in the FS and noted that herbicide research appears to be associated with regional rather than national research missions. Herbicide research is not included in any of the current national Priority Research Programs. Program coordination and direction are needed specifically on herbicide research and development, environmental fate, efficacy, and equipment development and testing.

b. Technical Exchange

Technical exchange protocols are needed with Canadian colleagues at FPMI, who are conducting herbicide research. More information exchange is needed with industry and universities. The California Forest Vegetation Management Conference is a good example of information exchange and such exchange should be encouraged within all Regions.

c. FPM Role

The role of FPM in herbicide management and application technology needs to be clearly defined. Due to FPM's broad responsibilities in pesticide-use management, herbicides have been "adopted" by FPM. FPM is not currently staffed nor funded specifically to provide the high level of technical expertise in herbicide-use that is necessary to support quality vegetation management decisions.

d. Management

Ways should be explored to increase management awareness of herbicide-use management needs and issues. This is a challenge to the creativeness of field and staff personnel who know the problems and are responsible for soliciting management support.

e. Responsibility

There is a need to insure that the FS is not perceived to be opposed to aerial spray. Our state and private cooperators, in some cases with similar and in some cases with dissimilar land management objectives, may require frequent use of aerial application. The FS must walk the "tight rope of objectivity" and not be caught in a contradictory position within its National Forest System (NFS) and State and Private Forestry (S&PF) role. The option of aerially applying herbicides must be maintained by the FS as supported by the NEPA process.

2. Training and Technology Transfer

a. Training

The Committee identified a need for Regions to provide herbicide-use training. This should include NEPA and tiering from programmatic to site specific documents, safety, application systems, and prescription processes. The Committee also noted that R-8 requires certification of FS contracting officers representatives and applicators for pesticide application projects.

b. Technology Transfer

NFS, Research (RES), and S&PF need to explore ways to deliver new herbicide technology to the user in a planned and systematic manner.

c. Reference Materials

National, Regional, and Forest level publications are needed to support training and for reference by users. Many existing herbicide-use publications are outdated and others need to be developed.

3. Cost Benefit Information and Data

General and specific information and data are needed on the cost benefits of herbicide use in all ecosystems. Although the Committee recognizes that the benefits of herbicides have been established under some conditions, cost benefit information and data are needed relative to: competition thresholds, efficacy, growth and yield, influence of herbicides over the rotation, effects of herbicides on crop trees, aerial vs ground application, loss of productivity associated with no herbicide use, and herbicide use strategies. Such studies require 10-20 years in some cases to complete and with the deferral of aerial spraying there is a continuing delay in delivery of such data.

4. Decision Support Systems

Rapid technological advances in computer modelling, expert systems and artificial intelligence are providing both opportunities and challenges to the resource manager. New tools are becoming available to assist in the timely, safe, and productive use of herbicides; however, this technology needs to be provided to practitioners. The Committee encourages the development and use of modelling, expert systems, and artificial intelligence in vegetation management, and sees an opportunity for the FS to provide national leadership through implementation of this technology.

5. Environmental and Safety Needs

a. Risk Assessment

A coordinated FS effort is needed to identify and pursue data gaps in risk assessments for new herbicides and application systems. Laboratory and field studies, combined with use of aerial application models, would be a sound approach toward filling data gaps in risk management.

b. Spray Accountancy

Field and spray model data are needed to account for and to quantify differences between the amount of herbicide applied by air or by ground methods, and the amount deposited on target. Spray drift is part of this problem. These data are needed for each herbicide and its associated spray systems.

c. Residue and Environmental Fate

As a continuation of spray accountancy, data are needed on the fate of herbicides once they deposit on or drift beyond the target area.

6. Biodiversity and Ecosystem Impact

Biodiversity was discussed by the Committee relative to the use of herbicides. There are opportunities to use herbicides to establish and maintain biodiversity of natural systems and manipulated stands. In contrast, disruptions of biodiversity are also a potential problem. Studies are needed on the role of herbicides in influencing biodiversity on Federal, state, and private lands. Data also are needed on the long-term effects of herbicides on ecosystems. The FS has an opportunity to provide national leadership on this issue.

7. Application Technology and Equipment

a. Turn-key Systems

Some chemical companies are packaging herbicides and application equipment into a single systems being referred to by the industry as turn-key systems. Currently turn-key systems are being used on large industrial ownerships in the South, especially in the coastal plain region. The State of Virginia has a successful state sponsored turn-key system available to small landowners. In some cases the applicator is licensed to use the system with the chemical company accepting liability. The Committee views this as a positive move and perhaps a way to resolve efficacy problems of the past. This approach does, however, pose possible administrative, contractual, and field management problems for the FS. The Committee suggests that those Regions planning to use turn-key systems work closely with their contracting officers.

b. Aircraft Guidance

Technology is available to accurately guide aircraft along predetermined spray swaths. The FS should re-examine aircraft guidance to identify what may be on the shelf, to ascertain technical feasibility, and to determine cost benefits of guidance systems. The Committee does not, however, recommend an aircraft guidance development program at this time.

c. Aerial Application vs Ground Application

Costs, benefits, safety, efficacy, and environmental impact of aerial vs ground application needs to be evaluated by the FS.

d. Aerial Application Models

Agricultural Dispersal (AGDISP) and Forest Service Cramer-Barry-Grim (FSCBG) aerial application models are operational and can be used to produce a catalogue of swath widths and deposition (spray volume, drop size, and particle and/or droplet density) for a range of release heights, wind speeds, relative humidities, temperatures, application rates, drop sizes, particle sizes, and aircraft types. The catalogue is needed by persons planning aerial application projects who may not have access or training in running these models.

e. Drop Size Efficacy

The traditional application rate of high volume (HV), 5 to 10 gallons per acre with spray applied in large drops (500-800 um VMD), is costly and sometimes not efficacious. Research by Oregon State University and FPMI supports lower volume application (LV) and even ultra low volume (ULV) with smaller drop sizes, possibly as low as 100 um VMD. Data are needed on drop size and its relationship to efficacy and drift. With such data the land manager can make the choice consistent with biological and social/political considerations.

f. Ground Application.

The Committee elected to include ground application within its discussions but not within the scope of this committee's assignment. The status and needs of ground application were discussed and the Committee offers for consideration the following equipment and development needs:

1. The development of integrated (i.e. a combined sprayer/planter) and environmentally safe ground application equipment.

2. The design of ground spray systems that optimize herbicide efficacy by controlling droplet size and pattern.

3. The design and development of low drift and wide swath ground systems.

4. The design of ergonomically designed backpack and tractor equipment.

Most ground application equipment has been borrowed from agronomy, with inherent limitations for forestry. As forest lands become more fragmented and buffer zones increase, the acreage delegated to ground treatment will increase. The Committee recognizes the significant contributions to ground application of herbicides within R-8.

III. DISCUSSION

The Committee noted a broad diversity in herbicide application needs, issues, concerns, and ideas within the committee. Members represented the three major organizational units of the FS, several scientific disciplines, and different geographical areas. This diversity provided a challenging opportunity for the Committee to take a national and broad overview of the herbicide application needs and issues, consistent with the intent of the Committee assignment. The plurality of views, concerns and needs expressed by the Committee members are not a result of disagreement on basic issues. Rather this diversity flows directly from the real differences that exist within and among the regions with respect to landownership and land management objectives for the various NFS and S&PF clients. The meeting also served as a preliminary national scoping session for future direction of herbicide use in the FS.

Two important findings surfaced at the meeting: there is much support for use and development of ground application equipment; and there is need to better define FS policy on aerial application of herbicides before the Committee can recommend specific pilot and field tests.

Ground application appears to be more acceptable to the FS and to the public than aerial application. There are supporting arguments for each method and each method should be evaluated on its own merits for specific site and project objectives. Generally data are lacking to support one application method over the other considering personnel safety, the environment, site characteristics, economics, and the public. The land manager needs scientific data to make wise choices.

Lack of a national policy statement on aerial application of herbicides inhibits research and development, and contributes to confusion on the part of land managers. The Committee believes that the FS shares a common view that the aerial option of applying herbicides must be maintained. A stated national policy therefore, is needed for guidance of NFS, RES, and S&PF;

and for those in the FS who support and those who do not support aerial application. Lack of a national policy is sending mixed signals to FS managers and to our cooperators.

A national policy should consider the following:

1. Needs in areas dominated by assertive environmental groups versus those needs dominated by timber production, where forest management practices are more culturally accepted.

2. Needs of the West, dominated by large contiguous tracts of federal ownership (FS, BLM, etc.), vs the needs of the East dominated by a mosiac of mixed ownerships and tract size some of which are in highly populated areas.

3. Needs of NFS vs need of other ownership that reflect different land management objectives; i.e. to meet multiple use objectives vs more limited land use objectives.

4. Needs of the small private landowner for economical delivery systems vs large corporations who can afford sophisticated and more costly delivery systems.

5. Needs for research and development to strengthen FS capacity to conduct quality herbicide application.

6. Concerns of our publics.

IV. SUMMARY

The National Steering Committee for Aerial Application of Pesticides - Vegetation Management met January 11-12, 1989 in Sacramento, CA. Ten of the 13 committee members were present, each presenting an overview of his work area and needs. The reports identified a diversity of needs and issues relating to application of herbicides, even within the same geographical areas. The plurality of views, concerns and needs expressed by the Committee members are not a result of disagreement on basic issues. Rather this diversity flows directly from the real differences that exist within and among the regions with respect to landownership and land management objectives for the various NFS and S&PF clients. This first committee meeting served to identify needs and issues and provided an opportunity for a general scoping of herbicide-use and management within the FS. Future committee meetings are contingent upon national needs that might best be served by the Committee. Two important findings surfaced during the meeting:

1. There is more concern and support currently for the development of ground application methods than for aerial application methods for use on NFS lands especially in the South; and

2. There is need to better define FS use of aerial application of herbicides before it will be possible to focus on specific FS pilot and field testing needs.

It is recommended that the Chief consider issuing a national policy statement on the aerial application of herbicides.

SECTION 5

RECOMMENDED GUIDELINES FOR DESIGNING FIELD EXPERIMENTS OF INSECTICIDES FOR CONTROL OF INSECT DEFOLIATORS BY AERIAL APPLICATION

PURPOSE

The purpose of this document is to set forth some guidelines that can be used by private industry, consultants, and others in planning field tests for aerial application of insecticides to control forest defoliators. This document describes the types of parameters and experimental design considerations that Forest Service scientists consider when evaluating the results of an insecticide field experiment to determine whether it warrants pilot testing. These guidelines are not meant to be rigid unalterable criteria, or exhaustive, but they will serve as a focal point for discussion in planning insecticide field tests.

INTRODUCTION

The Forest Service, USDA, uses a progression of tests to evaluate and recommend various insecticides for use in operational resource protection. These include laboratory screening, field experiments, and pilot projects. Here, the term insecticides refers to any material distributed for the purpose of protecting a forest resource from insect pests, and may include agents that kill the pest with some form of toxicant, or other materials that prevent a necessary behavior such as feeding, mating, ovipositing, aggregation, etc. Field experiments are conducted to evaluate one or more of following; determine the minimum effective dosage rates, different strategies, or formulations of the same material, or different applications equipment. In contrast pilot projects evaluate the most promising treatments identified by field tests. Usually only one variable, for example dosage or volume, is evaluated and the plots are large enough to simulate operational conditions. These operational simulations include such items as uncontrolled multiple swathings, formulation and mixing characteristics of large quantities, use over wide variations in physical conditions etc.

Regardless of the type of program being conducted it is critical to state the objective clearly, concisely and as specifically as possible. The objective may be to estimate treatment effects (contrasting postspray populations levels in both treatment vs. control, or population reductions by treatment vs. control etc.) or specifications to be met (i.e. a treatment must reduce the population at least 90% to be judged effective). Some field tests of insecticides may be planned to determine the lowest effective dose to achieve a certain percent control or residual population for each treatment and to compare treatments. Usually, experiments with such general purposes are evaluated by analyses of variance (ANOVA) with appropriate contrast for determining differences in treatment means.

To arrive at an effective design for either hypothesis testing or point estimation we must consider variabilility and cost. Because the criteria for judging effectiveness for the two goals are different, the design parameters, such as number of plots (replicates), number of trees (subsamples within a replicate) may differ. In many instances, however, both hypothesis testing and

point estimation are important in a single field experiment. It seems reasonable then that the design parameters that meet the design criteria for one goal and exceed the criteria for another goal should be used.

All insecticides used by the USDA Forest Service are registered by the U.S. Environmental Protection Agency (EPA) under the authority of the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA), as amended. However, additional research may need to be conducted on registered insecticides for the purpose of: (1) extending a registration to a new pest; (2) evaluating an insecticide's fate in the environment, (3) field testing an insecticides on a small scale, or (4) assessing environmental effects in specific forest habitats. When field tests are conducted on less than 10 cumulative acres,

experimental use permits (EUP) are not required. If research is done on an unregistered pesticide on more than 10 acres then an EUP is required and the guidelines in 40 CFR 172 must be followed. In addition to EUP's, it is usually appropriate to prepare a Forest Service pesticide-use proposal (FS 2100-2) for review, concurrence, and approval of the intended use.

EXPERIMENTAL DESIGN

1. Treated Areas: The following should be considered when selecting areas to be aerially treated with pesticides:

(1) First, the physiological health (quality) of the pest population should be known. Use of pest populations with recent history of stresses (i.e., acute competition for food, starvation, high virus incidence, recent epizootics, high level of parasitic activity of other chronic microbial infections) should be avoided if possible or at the very least noted. Using such populations of low quality could cause confounding effects and raise doubt concerning the reliability of the test results.

(2) Block size should be based on two considerations: (a) mobility of the pest and (b) type of aircraft planned for use. Blocks of at least 20 acres should be used when the target pest is not mobile and blocks of at least 30 acres should be used if the target pest tends to be mobile. Helicopters should be used to treat small blocks.

2. Replication: The function of replication is to provide an estimate of experimental error or natural variation and reduce confounding factors when attempting to measure treatment effects. The number of replications that will be required in a particular experiment depends on the magnitude of the differences to be detected and the variability of the data encountered. An experimental unit refers to the unit to which a treatment is applied. It can be a single leaf, an entire plant, or an area of ground containing many plants. Treatment replication is achieved when a treatment is randomly assigned to more than one experimental unit. Ensuring adequate replication within the confines of applicable constraints, such as manpower and cost, usually requires that treatment plots be small, i.e. 20-50 acre plots.

3. Randomization: Randomization functions to assure unbiased estimates of treatment means and experimental error. When conducting a field experiment to establish the efficacy of aerially applied insecticide in forestry, it is recommended that 2 or more variables (e.g., dose and volume) be tested in the same experiment. It is also further recommended that each variable be replicated 5X (no less than 3X will be accepted) and all treatments (including the fully replicated control) are to be assigned at random.

4. Sampling: Depending on the insect species, an appropriate sampling design must be described in detail so that population estimates can be displayed with their attendant measures of variation (standard deviations, standard errors of the mean etc.). Efficacy testing will be evaluated using

acceptable sampling designs. Treatment effects will be measured with, at minimum one pre treatment and one post-treatment estimate of the pest population's density. It is also highly recommended that periodic measurements to estimate treatment effects on the pest population density or of the protective effect of the insecticide be made at different time intervals. These intervals should coincide with the pest's own development rate or at different developmental stages, during the pest's active (e.g. feeding) period.

5. Data Analyses: To account for treatment differences, given natural differences and sampling error, the variables of interest must be defined i.e. the ratio of insects to foliage after treatment vs. before treatment. An estimate of this variable or other variables of interest and the components of the variances of the estimates can be computed on the basis of ratios of the plot means. Usually, the experiment will be designed to test differences between dose levels, or between treatments and control, for a number of insecticides. In this example, analysis of the experiment will then be evaluated by a one-way ANOVA with plot ratios as observations (experimental units) and insecticides at various levels with control treatments. Establishing confidence intervals for the treatment means provide an additional set of statistics that can be used to determine differences between treatments.

REQUIRED ANCILLARY DATA

1. Plot Descriptions: It is often helpful to describe the stand characteristics within which the experiment was conducted. This can often be useful in extrapolating the results to other geographical areas other than where the original experiments were conducted.

2. Spray Measurements: At a minimum spray deposit cards should be used to obtain a verification of qualitative spray deposits.

3. Aircraft and Spray Characterization: Data must be provided that describes aircraft type, aircraft speed, flow rate, nozzle type, number of nozzles, swath width, volume delivered per acre/hectare, active ingredient per acre/hectare, drop size, some measure of droplet distribution, droplet density etc.

4. Product Quality: In some instances (e.g., microbial pesticides), it is appropriate to test for product potency (quality) prior to use of the product. This will require drawing a pretreatment sample/s for bioassay. Analysis can be directed at determination of potency but can also be used to determine contamination if desired. With chemical insecticides it is recommended that tank samples be taken for each mixing batch for later determination of chemical concentration.

FURTHER CONSIDERATION

If desired, Forest Service personnel are available to review study plans prior to conduct of the field tests. To insure a timely and helpful review these study plans should be submitted to Director, WO-FPM, at least 45 days before test implementation.

DEFINITIONS

Analysis of Variance (ANOVA)- A statistical technique used to assess how several independent variables (ie. treatment groups) affect the mean(s) of the dependent variable (ie. insect population, defolation). ANOVA is usually concerned with comparisons involving several (> 2) population means.

Control (Checks) - A series of experimental units (ie. plots) receiving either the standard treatment or no treatment, but included in the experiment under the same conditions as the treatment of interest (ie. insecticide) and not systematically different from them.

Experimental-Use Permit - A permit issued by the Environmental Protection Agency of a State to allow experimentation with an unregistered pesticide or to allow a new use of a registered pesticide. The permit is issued upon determination that the applicant needs such a permit to gather information necessary to register the pesticide for a new use (40 CFR 172, Experimental-Use Permits).

Field Test - A research project considering several insecticide treatment variables under a variety of field conditions.

Operational Project - A full scale control project designed to utilize the best treatment materials, equipment, techniques and strategies available to treat a problem (in this instance, a forest defoliator infestation).

Pesticide - (1) Any substance or mixture of substances intended to prevent, destroy, repel, or mitigate any pest, or (2) and substance or mixture of substances intended for use as a plant growth regulator, defoliant, or desiccant.

Pilot Project - A special project that considers only a single treatment variable to determine the value of a new or improved material, technique, or strategy under simulated operational conditions.

Randomization - The assignment of treatments to experimental units so that all units have an equal chance of receiving a treatment

Registration - The process whereby the Environmental Protection Agency and States regulate the use of pesticides under authority of the Federal Insecticide, Fungicide, and Rodenticide Act, as amended.

Replication - The randomized treatments (including controls) are repeated on 2 or more experimental units. Its function is to provide an estimate of

experimental error or natural variation and reduce confounding factors when attempting to measure treatment effects.

Experimental Units - Area (plots) or objects (trees or leaves) that a single treatment is applied to and from which samples are drawn. The complete collection of these experiment units is the population to which inferences are made.

SELECTED REFERENCES

1. Williams, C.B. Jr., D.A. Sharpnack, L. Maxwell, P.J. Shea, and M. D. McGregor. 1985. Guide to testing insecticides on coniferous forest defoliators. USDA Forest Service. Pacific Southwest Forest and Range Experiment Station. Gen. Tech. Rept. PSW-85. 38pp.

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4. Milliken, G.A. and D.E. Johnson. 1984. Analysis of Messy Data. Chap.4. Basics of Experimental Design. Lifetime Learning Publ. NY,NY. 398p. (esp. p47-50).

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SECTION 6

RECOMMENDED GUIDELINES FOR DESIGN OF PILOT PROJECTS - AERIAL APPLICATION OF PESTICIDES (**DRAFT**) 10-18-89

I. INTRODUCTION

A. General

The USDA Forest Service (FS) conducts pilot projects to evaluate operational use of pesticides, application systems, and strategies to manage forest pests. Generally, the FS requires that a pesticide, application system, or strategy, be pilot tested following research and development, and prior to operational use. Decisions to proceed with a pilot project are based upon current or projected needs of the FS and availability of research data to support the new technology. Pesticides, application systems, and strategies customarily are researched or developed through the field testing stage, by the FS, other agencies, universities, or the private sector prior to being evaluated on a pilot project. Occasionally circumstances may dictate that a pesticide, application system, or strategy be pilot tested prior to completing research and development. In such cases that may be a cooperative field test and pilot project, with characteristics of both types of testing, but with major emphasis on an operational-scale variable. Pilot project design and conduct will vary depending upon test objective, criteria, and evaluation criteria e.g., evaluating biological effectiveness vs evaluating engineering performance of a spray system.

B. Purpose

The purpose of this document is to set forth a set of broad guidelines for planning and conducting pilot projects involving aerial application of pesticides, application systems, and strategies that will be applicable to the FS. Persons intending to conduct pilot projects are encouraged to follow these guidelines.

C. Background

The agency (FS or State cooperator) intending to use the pesticide, application system, or strategy operationally usually will participate in conducting the pilot project. In the process of conducting the pilot project the agency prepares for operational deployment of the pesticide, application system, or strategy. Thus, the agency determines during the pilot project whether it can use the pesticide, application system, or strategy effectively under operational conditions. There are, however, circumstances when a contractor might be contracted to conduct all or portions of a pilot project; or circumstances when a pesticide manufacturer or other private entity may conduct a pilot project in cooperation with the FS or a State cooperator.

D. Scope

The scope of this document covers pilot projects to evaluate the operational use of aerial application of pesticides, application systems, and strategies. The guidelines are oriented toward pesticide application projects; however, they are also applicable to pilot project evaluation of equipment and strategies. These guidelines are for use by public agencies and the private sector.

E. Definitions

Administrative Project (Study) - A special project conducted for a special local need of a District or Forest. The project may or may not include an accepted statistical design.

Application Systems - Spray application equipment that may include two or more of the following: aircraft, nozzles, aircraft guidance system, spray monitoring equipment, and other new equipment.

Control (Checks) - A series of units (i.e., blocks or plots) receiving no treatment and/or a standard or referenced treatment; and included in the experiment or pilot project under the same conditions as the treatment.

Cooperative Field Test and Pilot Project - A field project conducted cooperatively by FIDR and FPM that meets objectives of both a field test and a pilot project, and that meets the statistical design criteria of a field test.

Demonstration - A special project to demonstrate effectiveness of a product, equipment, or strategy; with or without the benefit of an accepted statistical design.

Field Test - An experiment designed to evaluate several treatment variables under field conditions.

Operational Projects - A full scale control project designed to utilize the best treatment materials, equipment, techniques, and strategies available to treat a forest pest problem.

Pesticide - (1) Any substance or mixture of substances intended to prevent, destroy, repel, or mitigate any pest, or (2) any substance or mixture of substances intended for use as a plant growth regulator, defoliant, or desiccant.

Pilot Project - A project with an appropriate statistical design and controls that simulates an operational-scale action, and considers only a single treatment variable to determine the value of a new or improved material, technique, or strategy. More than one variable (e.g., pesticide), however, may be tested concurrently.

Randomization - The assignment of treatments to units so that all units have an equal chance of being selected.

Replication - A treatment (including controls) which is repeated on three or more project units. Its function is to provide an estimate of natural variation and reduce confounding factors when measuring treatment effects.

Standard Treatment - A treatment using a product, equipment, or strategy for which the effectiveness is known or predictable.

Strategy - An approach to manage a forest pest that may include but not be limited to timing of treatment; size and frequency of treatment; combination of control methods; and other proven and unproven approaches.

II. GUIDELINES

A. Work Plan

A work plan should be prepared by the performing agency and coordinated with all interested parties. The plan should include the who, why, what, when, where, and how of the project. The objective, sampling methods, and analyses should be clearly stated and described. Work plans should also include operational aspects to include schedule of events, responsibilities, health and safety requirements, and background information on the items being tested (e.g., pesticide labels, material safety data sheets, and equipment specifications). As a guideline, the work plan should include sufficient detail to allow another person or group to conduct the pilot project. The pilot project design should include data collection and analyses that collectively might explain failures and successes.

A typical work plan, therefore, should include the following sections:

1. Introduction and Background
2. Objectives and Tasks
3. Project Area Description Physical and Biological
4. Pesticide, Application System, or Strategy Description
5. Project and Statistical Design, and Application Timing
6. Pesticide and Equipment Handling Procedures
7. Field Sampling Procedures
8. Laboratory Procedures
9. Environmental Monitoring
10. Data Analysis
11. Administration, Organization, and Budget
12. Safety, Hazard Analyses, Product Label, and Material Safety Data Sheet.
13. Public Involvement
14. Reporting Results and Technology Transfer

B. Criteria for Selecting Treatment Block

Criteria for selecting treatment blocks for pilot projects will vary depending upon objectives, available areas, environmental concerns, and other practical considerations. Pilot projects require replication of treatments and controls; therefore, blocks should be similar in size, elevation, exposure, stand composition, and in the case of pesticide application, the blocks should have comparable populations of pests. Treatment and control blocks should be spaced sufficiently apart to preclude drift from other blocks. All blocks should be monitored for drift contamination. Treatment blocks should be comparable in size to those that might be treated operationally. Size may range from a few acres (e.g., seed orchards and site preparation areas) to over a thousand acres (e.g., western spruce budworm control areas).

C. Criteria for Evaluation

A pilot project should have a sound statistical design. For reasons discussed above the design will vary from project to project. It is suggested that the statistical design be reviewed by a statistician, by a research specialist, and by future users of the technology being tested. Design of pilot projects should include control (check) blocks and appropriate replication of the test treatment. In cases where replication or control blocks are not feasible, the pilot project objectives should be reviewed, and consideration given to conducting some alternative evaluation such as a special demonstration or an administrative project. When this is done it should be with the understanding that project results will not be as meaningful as those of a field test or pilot project with appropriate replications and checks.

Control and treatment blocks should be selected randomly from a group of blocks with similar characteristics. A minimum of three replications for both treatment and control blocks is recommended. All treatment blocks should be selected randomly for treatment, even recognizing that practical considerations may argue otherwise for treatment blocks, in particular.

D. Measurement of Biological Processes

The selection of appropriate sampling procedures to obtain statistically accurate estimates of population densities and, when necessary, to monitor population development, is essential for the successful completion of any pilot project. Sampling procedures should be described in detail in the work plan and final report. Population estimates obtained as a result of following the selected sampling procedure should be displayed with their attendant measures of variation (standard deviations, standard errors of the mean, etc.). At a minimum at least one pre-treatment and one post-treatment population estimate using the selected sampling procedures must be made in both treated and untreated control blocks and the results reported. When treatment efficacy may be affected by proper timing in relation to the

target pest population, pest and host phenology information, if known, describing the lifestage distribution of the population during treatment should be reported.

Most major target pests have published sampling procedures. Examples of publications dealing with sampling procedures for Douglas-fir tussock moth, western spruce budworm, and gypsy moth are listed below:

Douglas-fir tussock moth

Mason, R.R. 1970. Development of sampling methods for the Douglas-fir tussock moth, Hemerocampa pseudotsugata Lepidoptera: Lymantriidae). Can. Entomol. 102:836-45.

Mason, R.R. 1979. How to sample Douglas-fir tussock moth larvae. USDA Agricultural Handbook No. 547, 15 pp.

Western spruce budworm

Carolin, V.M.; Coulter, W.K. 1972. Sampling populations of western spruce budworm and predicting defoliation on Douglas-fir in eastern Oregon. Res. Pap. PNW-149. Portland, OR, 38 pp.

Mason, R.R.; Wickman, B.E.; Paul, H.G. 1989. Sampling western spruce budworm by counting larvae on lower crown branches. PNW-RN-486, 8pp.

Srivastava, N; Campbell, R.W.; Torgersen, T.R.; Beckwith, R.C. 1984. Sampling the western spruce budworm: fourth instar, pupae,and egg masses. Forest Science 30(4):883-892.

Gypsy moth

Wilson, R. W., Jr.; Fountaine, G. A. 1978. Gypsy moth egg-mass sampling with fixed and variable radius plots. USDA Agricultural Handbook No. 523, 46 pp.

Kolodny-Hirsch, D. 1986. Evaluation of methods for sampling gypsy moth egg mass populations and development of sequential sampling plans. Environ. Ent. 15:122-7.

Dubois, N.; Reardon, R.; Kolodny-Hirsch, D. 1988. Field efficacy of the NRD-12 strain of Bacillus thuringiensis against gypsy moth. J. Econ. Ent. 81:1672-1677.

Sampling procedures for some target pests may not be adequately addressed in published literature. In these cases procedures should be selected based on recommendations made by recognized specialists.

In addition to the sampling requirements detailed above, several other procedures may help a potential user interpret the results, and thus

improve the credibility and acceptance of pilot project results. Biological assays (tests of the performance of field applied pesticides in a controlled environment on susceptible lifestages of the target insect) help to ensure that reported differences between mortality rates in the treated and control blocks resulted from exposure to the pesticide. Measurement of the pesticide potency obtained by quantifying the amount of active ingredient in sub-samples of each field batch provides additional information on potential effectiveness of the pesticide. Implementing procedures within the pilot project to fill data gaps on the effects on non-target organisms are encouraged.

E. Measurement of Physical Processes

The physical environment may have a major impact on the performance of a pesticide, application system, or strategy. The physical environment, therefore, should be considered during project design, conduct, and data evaluation and described in the pilot project report. It is assumed that the pilot project will be conducted at a location that is physically comparable to where it may be deployed operationally. Topography (elevation, slope, surface cover, and soil types) and atmosphere (wind, temperature, and moisture) can have a dramatic influence on performance of a pesticides, application systems, or strategies. Procedures for monitoring the resulting data should be included in the report. For example, application success in a low elevation, moderate terrain may not be repeatable in higher elevations and more complex terrain. Similarly, atmospheric conditions combined with topographical factors, may have a dramatic influence on dispersion of sprays and performance of equipment.

Meteorological measurements should be collected to:

1. Aid in spot forecasting and scheduling.

2. Provide the project director input for operational decisions.

3. Document events for post-spray analysis, modeling, and legal reference.

Two references on forest meteorology are:

Ekblad, R. B., H. E. Cramer, and R. K. Dumbauld. 1978. Meteorological considerations and measurements. In: The Douglas-fir Tussock Moth: A Synthesis; Forest Service, Science and Education Agency, Technical Bulletin 1585. U.S. Department of Agriculture, Washington, D.C.

Schroeder, Mark J. and Charles C. Buck. 1977. Fire Weather. Agriculture Handbook 360. U.S. Department of Agriculture, Forest Service, Washington, D.C.

F. Measurement of Physical Performance

The pilot project should provide for acquisition of data to evaluate the physical performance of the pesticide, application system, or strategy. This often is overlooked by scientists who may focus primarily on biological results. To illustrate with an example - you are testing a proven pesticide against a defoliator that concentrates in the upper tree crown. The test did not meet your control expectations and you may have doubts about its effectiveness. Why did it not perform? To evaluate this poor performance you need data on spray deposition in upper crown, spray atomization, aircraft calibration and performance, aircraft application, physical properties and handling of the tank mix, as well as information discussed in paragraphs II, E.

G. Environmental Monitoring

Design and conduct of pilot projects should consider environment protection consistent with the National Environmental Policy Act. Equal protection should be provided on private, State, and Federal lands. The pilot project objective should include determining or evaluating potential environmental impact of the pesticide, application system, or strategy being tested. Recognizing that such data may have been obtained during field or development testing, it is important to recognize that the purpose of a pilot project is to evaluate performance under semi-operational conditions. As an example, drift may be minimal on a 20 acre block when sprayed by a small helicopter close to the canopy, over moderate terrain. Scaling up from a 20 acre field experiment to a pilot project may involve several thousand acres, the aircraft may be a large helicopter or fixed-wing that flies higher above the canopy, and the terrain more complex.

Drift is inevitable - but how much and is there an impact? Such data are needed for operational evaluations.

H. Pesticide Application Equipment, and Strategies

The system being evaluated on a pilot project should be the system that in all probability would be deployed operationally. The project may be for a pesticide, an item of application equipment, a strategy, or a combination of these three. The pesticide tank mix, the aircraft and atomizer type, and strategy to be evaluated on a pilot project should be the same system planned for operational use; recognizing practical considerations.

WO/FPM staff is available to assist in reviewing work plans and operation plans, and providing advice as requested.

I. Reporting Results

Timely reporting of pilot projects is essential to efficient use of the technology being evaluated. A preliminary report should be available

within four months of completing the field operation and a final report within one year. In addition to results the report should include as appropriate the factors listed in paragraph II, A. Journal publications should be considered when appropriate. The preliminary report may be critical to budget planning of follow-on testing or for operational deployment of the tested product.

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This draft 6-22-89 considered comments received from M.Ollieu, D.Hamel, and G.Daterman.

This draft 7-20-89 considered comments received from J.Weatherby, G.Daterman, R.Reardon, D.Hamel, and T.Hofacker.

This draft 8-31-89 considered comments received from WO-FIDR, WO-FPM (D.Hamel); NA (D.Kucera, J.Hanson, I.Millers); PNW (G.Daterman); R-6 (B.Ciesla); Idaho (L.Livingston); R-8 (J.W.Taylor); and R-2 (D.Johnson).

This draft 10-17-89 reflects written comments from I.Ragenovich and verbal comments received at the western defoliator committee meeting on 10-12-89.